

(12) UK Patent Application (19) GB (11) 2 320 984 (13) A

(43) Date of A Publication 08.07.1998

(21) Application No 9700093.9

(22) Date of Filing 04.01.1997

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(51) INT CL⁶

H01H 85/00 85/12

(52) UK CL (Edition P)

H2G GAP
U1S S1820

(56) Documents Cited

GB 1313065 A
WPI Abstract Accession No 91-064620/09 & SU
1576930A(Lengd) 07.07.90 (see abstract)

(58) Field of Search

UK CL (Edition O) H2G GAA GAP GBX
INT CL⁶ H01H 85/00 85/041 85/044 85/12
ONLINE:WPI

(54) Abstract Title

Electrical fuses

(57) A fuse device 20 has a first fusible conductor 32 arranged to carry electrical current during normal operation, and to blow at 50A, and a second conductor 38 arranged to be connected to earth via a diode 62 so that it will only conduct when the power supply to the circuit is reversed. Both conductors 32, 38 pass over a layer of combustible material, and the second conductor 38 has a narrow fusing section (56, fig 30) which is arranged to ignite the combustible material at relatively low reverse current. This blows the first conductor thereby cutting off reverse current through the circuit before it reaches a harmful level. The device may protect against reverse currents in circuits including FETs, eg. in vehicle electrical systems.

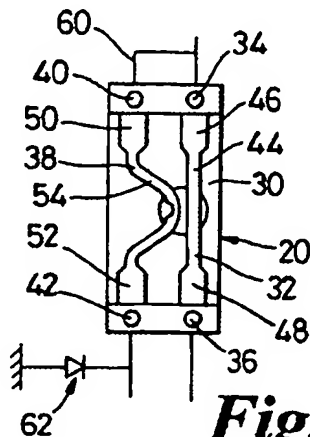


Fig. 2

GB 2 320 984 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Electrical Fuses

The present invention relates to electrical fuses and to the protection of electrical circuits from reverse currents.

With increasing use of field effect transistors (FETs) in electronic circuits, it is becoming increasingly important to provide protection against
5 reverse currents.

Fuses are widely used to protect electric circuits against excessive currents. They generally have a time v. current profile which ensures that they will fuse and open the circuit when the current through them exceeds a desired maximum, either by a large amount for a short period or by a
10 smaller amount for a longer period. However, standard fuses cannot differentiate between forward and reverse currents. Therefore, if protection is required against a relatively high forward current and a relatively low reverse current, separate fuses are normally required.

Accordingly the present invention provides a reverse current protection
15 system for an electrical circuit, the system including a first fusible conductor for connection in series with a power supply and a load and for passing current in a forward direction when the power supply produces a forward voltage across the load, and being arranged to open the circuit when the current through it exceeds a first fusing current, a second conductor for
20 connection to said power supply, diode means arranged to allow current to flow through the second conductor only when the power supply produces a reverse voltage across the load, and severing means arranged to be activated by current flow in the second conductor to sever the first conductor

before the reverse current in the first conductor exceeds a second fusing current, the second fusing current being less than the first fusing current.

The second fusing current may be less than the first in that it is of a shorter duration but the same magnitude, or in that it is of a lesser
5 magnitude but of the same duration. Desirably, the profile of the fuse will be such that a second fusing current which is lesser in either magnitude or duration will be effective.

The combustion means preferably comprises an amount of combustible material, such as fulminate of mercury or that used in electrically ignited
10 squibs for airbags and the like.

Preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

Fig. 1 is a diagram of an electrical circuit including a reverse current
15 protection system according to the invention,

Fig. 2 shows a fuse device forming part of the reverse current protection system of Fig. 1, and

Fig. 3 is a detailed view of part of the fuse device of Fig. 2.

Referring to Figure 1, a vehicle electrical system comprises a battery 10
20 and an alternator 12 arranged to charge the battery via a rectifying diode bridge 14 (represented schematically in the drawings). A fuse 16 between the battery and the diode protects the battery from discharging in the event of accidental grounding of the circuit near the alternator or diode bridge.

The positive terminal 18 of the battery is connected via a fuse device 20 to the power input 22 of a light switch module 24. A number of lights of the vehicle, represented as a single bulb 26, are connected between the power output 28 of the light switch module 24 and ground. The light switch
5 module includes a number of switching devices including a number of FETs.

Referring to Figure 2, the fuse device 20 comprises an electrically non-conductive substrate 30 with a first fusible link 32 on its surface extending between first and second terminals 34, 36, and a second fusible link 38 also on its surface extending between third and fourth terminals 40, 42. The first
10 and third terminals 34, 40 are at one end of the device 20, and the second and fourth terminals 36, 42 are at the other end. The first link 32 has a straight central portion 44 of substantially constant width and thickness, and a wider portion 46, 48 at each end where it is connected to the first and second terminals 34, 36. The central portion 44 is dimensioned so that it
15 will fuse when the current through it reaches 50A. The second link 38 has a wide portion 50, 52 at each end where it is connected to the terminals 40, 42, and a narrower central portion 54.

The first and third terminals 34, 40 of the fuse device 20 are electrically connected together by a wire 60, and both normally connected to the positive
20 terminal 18 of the battery. The second terminal 36 is connected to the power input 22 of the light switch module. The fourth terminal 42 is connected via a diode 62 to ground. The diode is arranged so as to allow current to flow in the direction from ground through the second link 38 towards the battery 10, but to prevent current flowing from the battery 10 through the second
25 link 38 to ground.

Referring to Figure 3, the central portion 54 of the second link 38 is curved so that in a region near its centre it comes close to the first link 32, but is electrically isolated from it by a narrow gap 55 between the two links 32, 38. At the middle of the central portion 54, where it is closest to the first link 32, there is a fusing section 56 which is narrower than the rest of the central portion 54. This fusing section is arranged to increase in temperature significantly faster than the rest of the central portion. A layer of electrically non-conductive combustible material 58 is deposited on the surface of the substrate 30 over an area 60 in its centre such that the central portion 44 of the first link 32 and the fusing section 56 of the second link 38 lie on top of it. The combustible material is arranged to be ignited when the temperature of the fusing section 56 exceeds a predetermined ignition temperature. This is arranged to happen before the reverse current through the light switch module 24 is sufficient to cause damage to the FETs it contains. For a relatively low reverse current of, say, 1A, the combustible material will be ignited after about 10s. If the reverse current is higher than this, say about 10A, the combustible material will be ignited in a much shorter period, say about 0.5s.

Under normal operation, with the battery connected up correctly as shown, when the light switch module 24 is operated to turn on one or more of the vehicle lights 26, current flows through the first link 32 of the fuse device 20, through the light switch module, and through the lights 26. The diode 62 prevents current from flowing through the second link 38. The fuse device 20 therefore behaves as a normal fuse, and blows if the current through the switch module 24 exceeds 50A for 10s.

If the battery is connected up the wrong way round, or if jump leads from another battery are connected to the circuit the wrong way round, the

first and third terminals 34, 40 of the fuse device 20 are connected to a negative battery terminal which causes current to flow in the reverse direction through the lights 26, the light switch module 24 and the first link 32 of the fuse device 20. However, it also causes current to flow through the
5 second link 54 of the fuse device 20 and the diode 62. As this reverse current begins to flow, provided the reverse voltage is high enough and applied for long enough, the temperature of the fusing section 56 of the second link 32 increases to a point where it ignites the combustible material 58. This breaks the first link 32 thereby cutting off the reverse current through the
10 light switch module 24, before that reverse current has reached a level where it will damage the module 24, and in particular the FETs in it.

It will be appreciated that the conductors of the fuse device could take other forms, and could for example comprise wires passing through a bead of combustible material, which would surround them and fill the insulating
15 gap between them.

CLAIMS

1. A reverse current protection system for an electrical circuit, the system including a first fusible conductor for connection in series with a power supply and a load and for passing current in a forward direction when the power supply produces a forward voltage across the load, and being arranged to open the circuit when the current through it exceeds a first fusing current, a second conductor for connection to said power supply, diode means arranged to allow current to flow through the second conductor only when the power supply produces a reverse voltage across the load, and severing means arranged to be activated by current flow in the second conductor to sever the first conductor before the reverse current in the first conductor exceeds a second fusing current, the second fusing current being less than the first fusing current.
2. A system according to claim 1 wherein, for each of a range of forward current magnitudes, the period in which the first conductor will fuse is longer than the period in which the severing means will sever the first conductor when the first conductor is carrying a reverse current of equal magnitude.
3. A system according to claim 1 wherein, for each of a range of forward current fusing periods, the forward current required to fuse the first conductor is of greater magnitude than the reverse current which will flow in the first conductor when the current in the second conductor is of a magnitude to cause the severing means to sever the first conductor within the same period.

4. A system according to any foregoing claim wherein the combustion means comprises combustible material which is in contact with the first and second conductors such that it can be activated by heat produced by the current in the second conductor to sever the first conductor.
5. A system according to claim 4 wherein the combustible material is supported on a substrate.
6. A system according to claim 4 or claim 5 wherein at least one of the conductors and the combustible material are supported on a common substrate.
7. A reverse current protection system for an electrical circuit substantially as hereinbefore described with reference to the accompanying drawings.

Fig. 1

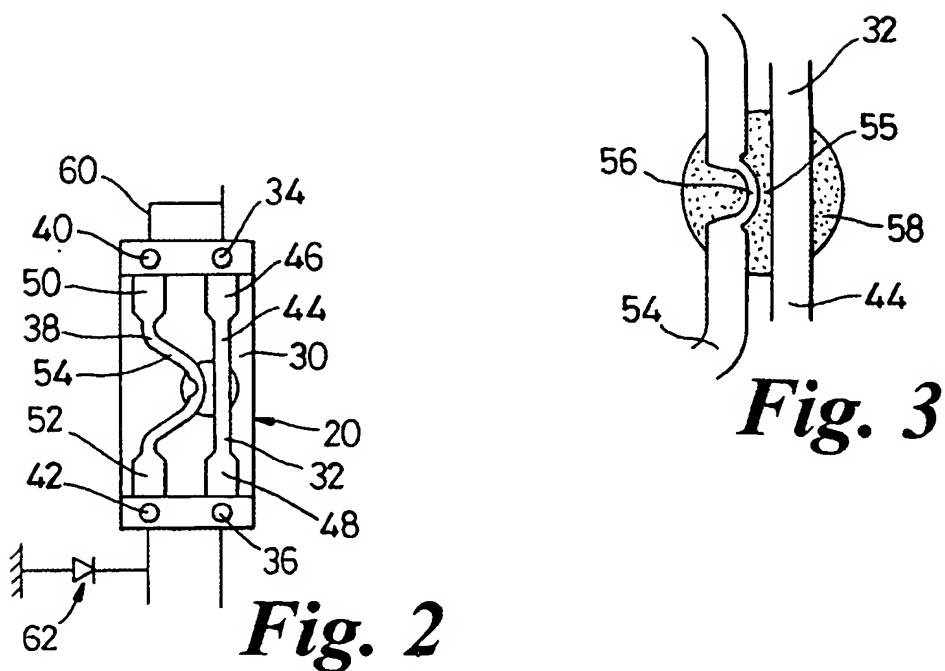


Fig. 3



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Application No: GB 9700093.9
Claims searched: 1-7

Examiner: Miss J.E. Evans
Date of search: 6 March 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H2G (GAA,GAP,GBX)

Int Cl (Ed.6): H01H 85/00,85/041,85/044,85/12

Other: ONLINE:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB1313065 (General Motors) see fig 10 and abstract	1
A	WPI Abstract Accession No. 91-064620/09 & SU 1576930A (Lengd) 07.07.90 (see abstract)	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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4/10/2006, EAST Version: 2.0.3.0